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# Results of Stabilized Waste Material Testing for the Raymark Superfund Site

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## PREFACE

This report was prepared by Dr. Vincent C. Janoo, Research Civil Engineer, Lynette A. Barna, Civil Engineer, and Sherri A. Orchino, Civil Engineering Technician, Civil Engineering Research Division, Research and Engineering Directorate, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. Funding was provided by the U.S. Environmental Protection Agency (EPA) through the U.S. Army Corps of Engineers, New England District (NED).

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Field work is labor intensive and requires the assistance and cooperation of a team. The authors thank the CRREL field crew who aided in gathering data during the trips to Stratford: Troy Arnold, Charles Smith, Jeffrey Stark and Anthony Wood. They also thank Kurt Knuth, who aided in installing and monitoring the electronic collection systems.

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# Results of Stabilized Waste Material Testing for the Raymark Superfund Site

VINCENT C. JANOO, LYNETTE A. BARNA, AND SHERRI A. ORCHINO

## INTRODUCTION

CRREL was approached by the Geotechnical Engineering Division of the New England District (NED), U.S. Army Corps of Engineers, to assist in predicting the effects of freeze–thaw cycling on stabilized hazardous waste material. The stabilized waste material is being used as a fill material below the pavement structure at the Raymark Superfund site in Stratford, Connecticut. This report focuses on the testing methods and results obtained from the field work.

The Raymark Superfund site is currently under remediation with the intention of using the reclaimed land for commercial development. A portion of the site is planned to be used as a parking area, and the pavement structure of the proposed parking area will consist of a layer of bituminous concrete over a graded gravel base. The total pavement structure thickness will be 559 mm. The pavement structure will be either 76 mm of asphalt concrete over 483 mm of gravel base for standard duty traffic, or 102 mm of asphalt concrete over 457 mm of gravel base for heavy duty traffic loads. Below the pavement layer will be 203 mm of a common granular fill material followed by a 152-mm layer of Tilcon common granular fill.

Geosynthetic liner materials, approximately 25 mm thick, will be placed below the Tilcon material. A minimum thickness of 914 mm of materials will be placed above the geosynthetic liner materials. Below the geosynthetic liner materials is a 203-mm sand gas collection layer. The undermost layer is the waste material, which is a mixture of on-site soil combined with hazardous waste that was produced on site. Asbestos, lead, PCBs, volatile organic compounds (VOCs), semi-VOCs, and solvents have been detected in the on-site soil. This mixture was treated with 3.5% cement and compacted prior to placement of the geosynthetic liner materials.

As the 1996–97 winter season approached, it was apparent that not all of the stabilized waste material areas would be covered with the base and subbase. Therefore, field tests were conducted to evaluate any changes in the strength of the stabilized fill caused by frost effects. In the event that a significant decrease in strength occurred, the material would have to be restabilized prior to the placement of the upper layers.

Field testing of the stabilized waste material was conducted to determine the unconfined compressive strength and the CBR (California bearing ratio) of the material before and after freezing. The tests were conducted with a Clegg impact soil tester and dynamic cone penetrometer (DCP). Field testing was conducted in December 1996 and in March 1997.

A secondary objective of the test program was to determine if the design thickness of the subbase material was sufficient to prevent frost penetration into the stabilized fill. Thermocouples were installed in the subbase materials to record temperatures at various depths. These data were then used to predict the depth of frost penetration in the waste material.

Because of the large volume of data generated, the appendices accompanying this report are summaries of the actual data obtained from the testing at the site. The raw field data are available upon request.

## STABILIZED SOIL TESTING

Clegg hammer and DCP testing at the site was performed at three field test sites (Fig. 1). At each test site, a 15- × 3-m grid was laid out (Fig. 2). Three 15-m testing lines were established in this

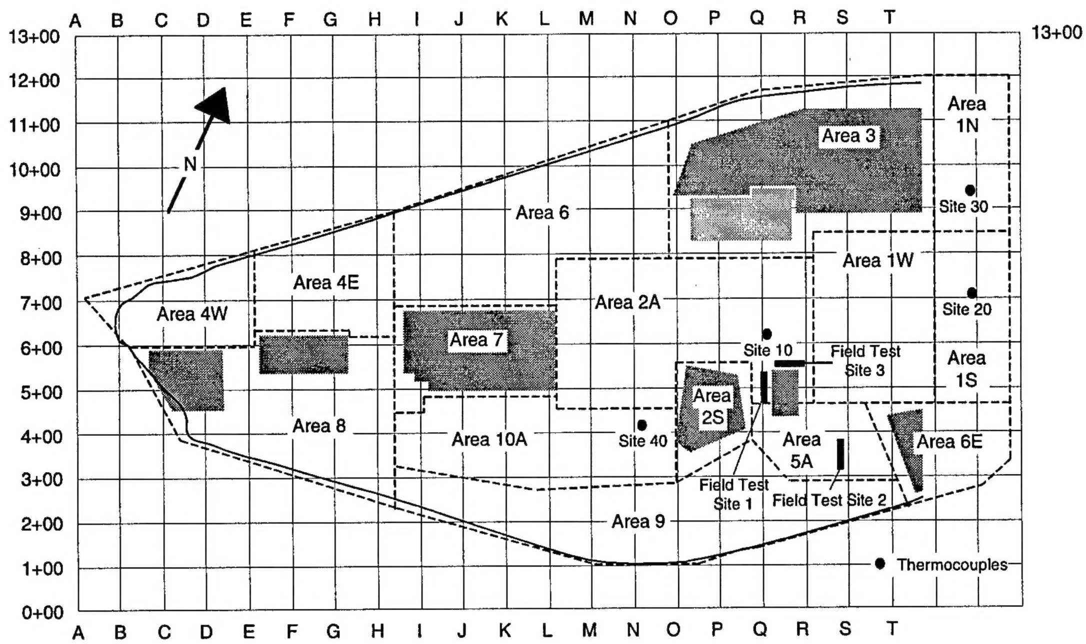



*Figure 1. Raymark Superfund site map.*

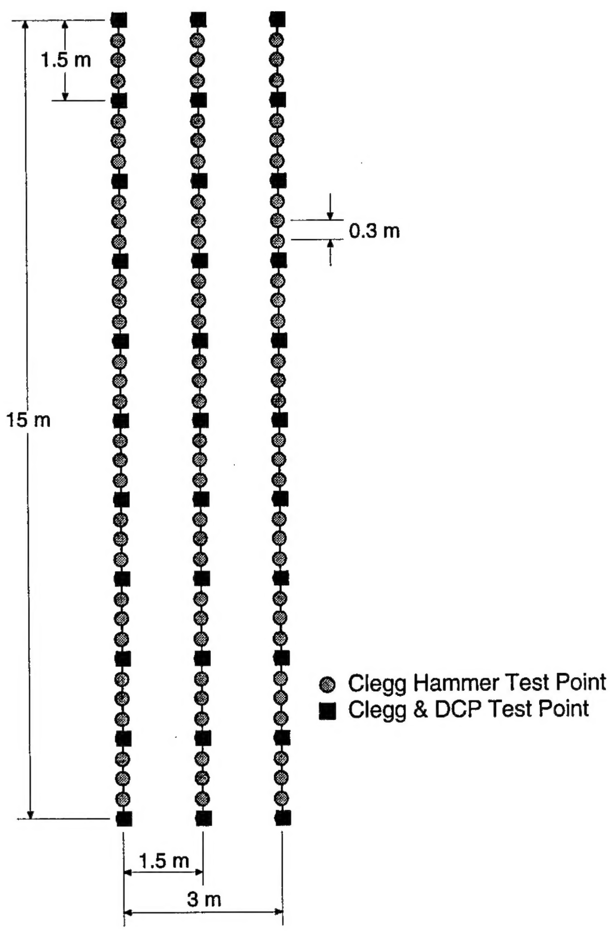



*Figure 2. Test site grid layout.*

grid, one at center and one 1.5 m to each side of center. Clegg hammer tests were done at 0.3-m spacing along each of the three lines for a total of 153 points on each site. Dynamic cone penetrometer testing was conducted at 1.5-m intervals along each of the 15-m lines, for a total of 33 points per site on both site 1 and site 3. The assumption is made here that all three of the testing sites are representative of the overall Raymark Superfund site, and the results obtained are applicable to the overall site.

Because of the variability of the material on the site, we determined that the analysis be based on statistical examination of the field data. The 15- × 3-m grids were selected to ensure adequate statistical sampling. Selection of testing areas was based on the availability of uncovered stabilized waste material not designated for construction prior to the close of the site for the winter. As shown on the site map (Fig. 1), field test site 1 and 3 were located in area 2A; field test site 2 was located in area 5A, based on one specified area of uncovered stabilized material.

Initial test site locations were field test sites 1 and 2. However, during preliminary DCP testing at field test site 2, driving the DCP into the soil was difficult, because of the soil's high strength, without damaging the equipment. After consulting with NED personnel, field test site 3 was selected as an alternative testing site. Even though DCP testing was not possible on field test site 2, Clegg hammer tests were completed.

## Clegg impact hammer

The Clegg hammer was used to determine the unconfined compressive strength of the stabilized waste material at all three test locations. Figure 3 illustrates the Clegg hammer, which consists of a 4.5-kg compaction hammer, a guide tube, and an electronic display. The weight of the hammer is based on the hammer used in the American Society for Testing and Materials (ASTM) "Modified Proctor" test (ASTM D1557-91). The hammer is raised in the guide tube until a white line etched on the hammer is even with the top of the tube; this ensures that the proper drop height of 450 mm is maintained. An accelerometer built into the hammer measures the peak deceleration of the hammer when it impacts the soil surface. The hammer is dropped four times at each test point. The electronic display shows the highest deceleration value at each point as a Clegg impact value (CIV).

*Figure 3. Clegg impact hammer testing.*

Okamoto et al. (1991) performed a study using six soil types with varying cement contents ranging from 2 to 16%. The American Association of State Highway and Transportation Officials (AASHTO) soil classifications A-1a to A-3, representing the range of cohesionless soils, were compacted at optimum moisture content as determined by ASTM D533-82, *Test Method for Moisture-Density Relations of Soil-Cement Mixtures.* Cylindrical specimens were made for testing with the impact hammer, while companion samples were made for standard testing of compressive strength of soil-cement cylinders (ASTM D1633-84). The samples were tested after 1, 2, 3, 5, 7, 10, 14, and 17 days of curing under wet burlap. A regression analysis of compressive strength on impact values was done for the soil types (as shown in Fig. 4). These data were plotted on a log-log scale and the 95% confidence level was determined (Fig. 5). With the information from this study, the CIV may be correlated to unconfined compressive strength (psi) using eq 1:

$$\log(f_c') = 0.081 + 1.309\log(\mathrm{CIV}) \quad (1)$$

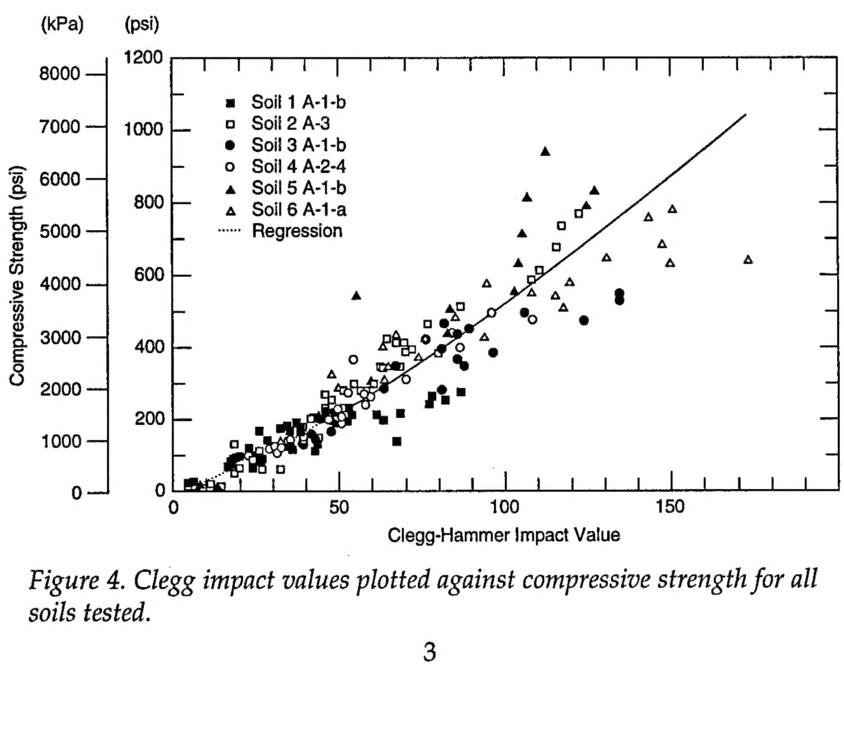



*Figure 4. Clegg impact values plotted against compressive strength for all soils tested.*

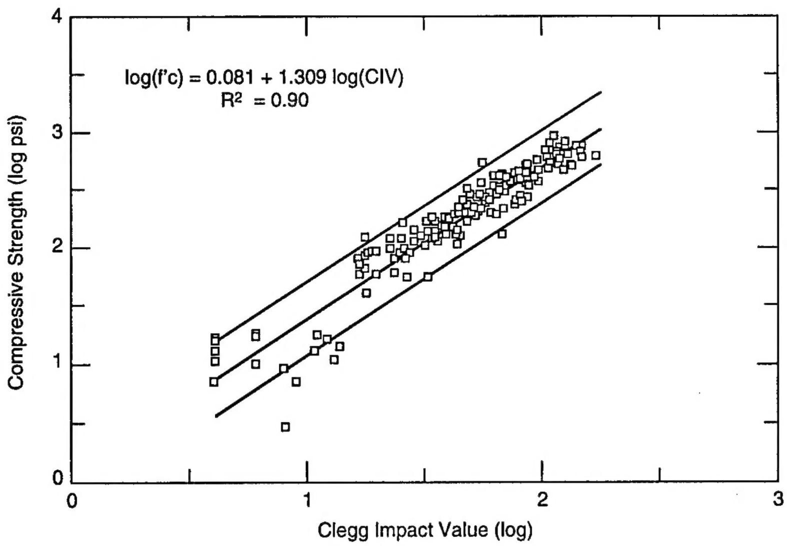



*Figure 5. Clegg impact values plotted against compressive strength and showing 95% confidence bars.*

where $f_c'$ is unconfined compressive strength and CIV is the Clegg impact value.

The CIV may also be correlated to California bearing ratio (CBR) (Yoder et al. 1991) using eq 2:

$$CBR = CIV^2 \times 0.07. \quad (2)$$

**Dual-mass dynamic cone penetrometer (DCP)**

The dual-mass dynamic cone penetrometer (DCP) was used at two site locations (field test sections 1 and 3) at the Raymark site to determine the CBR of the stabilized waste material to a depth of 460 mm. Figures 6a and b illustrate the use of the DCP equipment. The DCP consists of a steel rod with a cone attached to one end. This rod is driven into the ground by a 8-kg sliding weight, which is dropped 574 mm onto an anvil at the top of the rod. The DCP is a dual-mass penetrometer, because the steel outer sleeve of the sliding weight may be removed to produce a 4.6-kg weight for use in softer soils. In the case of the Raymark stabilized waste, the 8-kg weight was used. The U.S. Army Engineer Waterways Experiment Station established a database of field CBR values vs. DCP index values of different soil types from various sites (Webster et al. 1992). Figure 7 shows a plot of

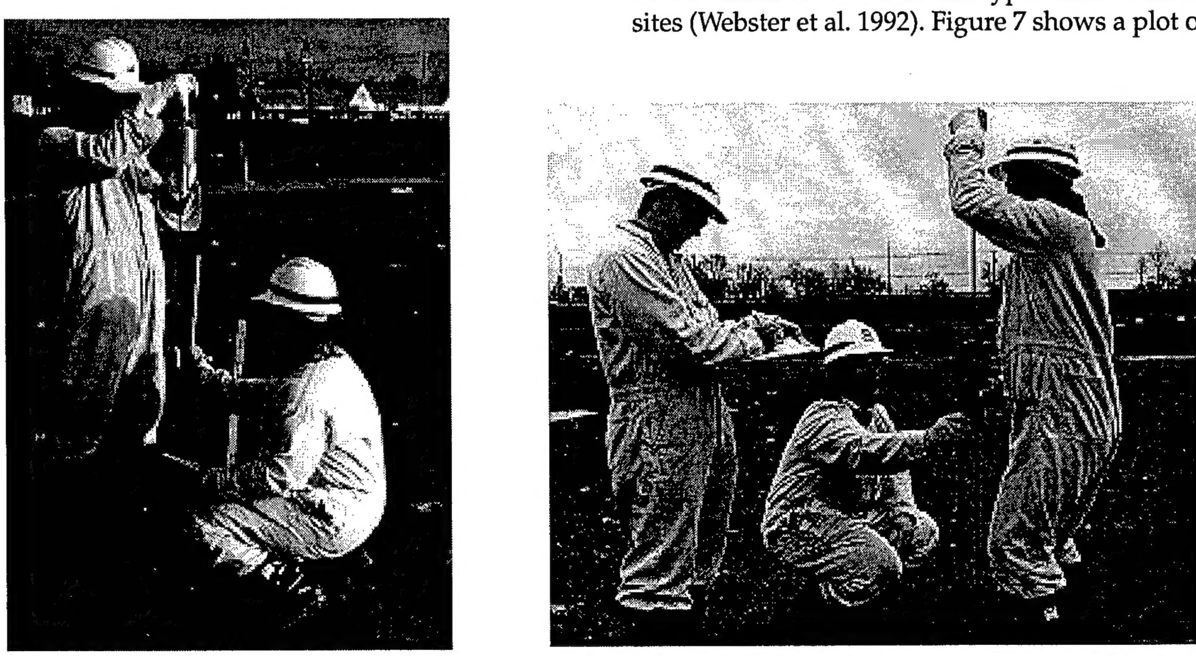


*Figure 6. DCP testing.*

the correlation of CBR vs. DCP to produce eq 3:

$$CBR = 292/DCP^{1.12}. \qquad (3)$$

The DCP data are recorded as the number of blows needed to drive the penetrometer in increments of not less than 25 mm of penetration. Figure 8 (Kessler Soils Engineering Products 1996) is a sample of a typical data sheet. When the maximum penetration has been reached, the DCP is removed from the hole by driving the sliding weight against the top handle. Disposable cones were used during the spring field testing to minimize wear and tear on the equipment.

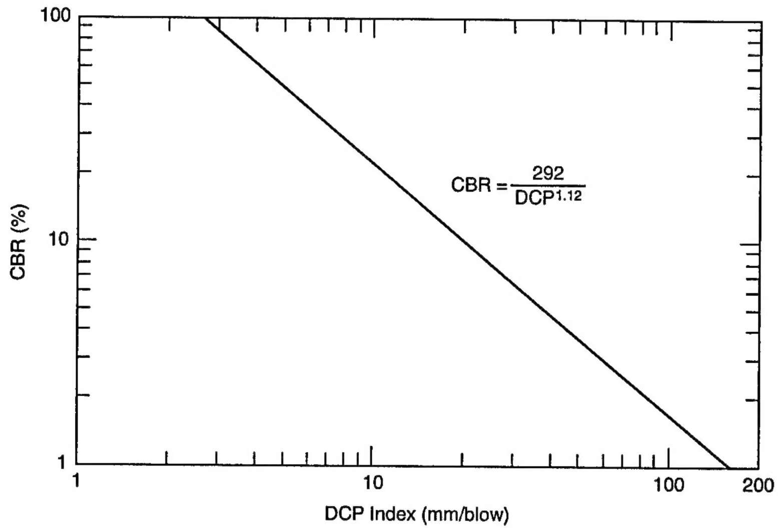



*Figure 7. Correlation plot of CBR vs. DCP index.*

**Project** Raymark Superfund Site **Date** March 12, 1997

**Location** Site 3 North 0+00 **Soil Type(s)** stabilized waste material

| No. of blows (1) | Accumulative penetration (mm) (2) | Penetration per blow set (mm) (3) | Penetration per blow (mm) (4) | Hammer blow factor (5) | DCP Index (6) | CBR (%) (7) | Depth (in) (8) |
|---|---|---|---|---|---|---|---|
| 0 | 0 | ---- | ---- | 1 | ---- | ---- | 0 |
| 3 | 25 | 25 | 8.3 | 1 | 8.3 | 27 | 1.0 |
| 10 | 55 | 30 | 3.0 | 1 | 3.0 | 85 | 2.2 |
| 10 | 80 | 25 | 2.5 | 1 | 2.5 | 105 | 3.1 |
| 10 | 110 | 30 | 3.0 | 1 | 3.0 | 85 | 4.3 |
| 15 | 150 | 40 | 2.7 | 1 | 2.7 | 97 | 5.9 |
| 10 | 190 | 40 | 4.0 | 1 | 4.0 | 62 | 7.5 |
| 10 | 230 | 40 | 4.0 | 1 | 4.0 | 62 | 9.1 |
| 10 | 270 | 40 | 4.0 | 1 | 4.0 | 62 | 10.6 |
| 10 | 330 | 60 | 6.0 | 1 | 6.0 | 39 | 13.0 |
| 10 | 390 | 60 | 6.0 | 1 | 6.0 | 39 | 15.4 |
| 8 | 435 | 45 | 5.6 | 1 | 5.6 | 42 | 17.1 |
| 8 | 480 | 45 | 5.6 | 1 | 5.6 | 42 | 18.9 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

(1) No. of hammer blows between test readings
(2) Accumulative penetration after each set of hammer blows
(3) Difference in accumulative penetration (2) at start and end of hammer set
(4) (3) divided by (1)
(5) Enter 1 for 17.6 lb hammer; 2 for 10.1 lb hammer
(6) (4) x (5)
(7) From CBR versus DCP correlation
(8) Previous entry in (2) divided by 25.4 rounded off to 0.1 in.

*Figure 8. Example of completed DCP data sheet for the Raymark Superfund site.*

## TEMPERATURE DATA AND ANALYSIS

Thermocouples were installed at the site in December/January at four locations (see Fig. 1: thermocouple sites 10, 20, 30 and 40) and recorded data throughout the freezing season. Thermocouples were installed during December at sites 10, 20 and 30. Site 40 was installed during a site visit in January. The data gathered from the thermocouples were used to determine whether 910 mm of material was a sufficient thickness to prevent frost penetration into the stabilized waste material.

At sites 10 and 20, the thermocouple strings were installed into the Tilcon common granular fill material. Site 30 was located in another sub-

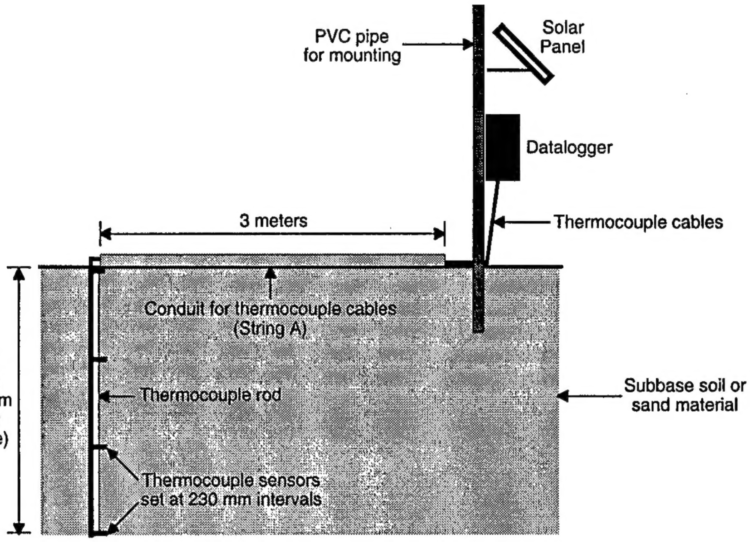



*Figure 9. Thermocouple configuration.*

base material identified as J.J. Brennan fill, and site 40 was placed in the sand material, which was used for the gas collection layer above the waste material. Each location for thermocouple placement was selected based on a minimum of 910-mm coverage of the geosynthetic materials and waste material. Thermocouple strings were not installed in the stabilized waste material. The assumption was that temperatures recorded at the four thermocouple sites would be also representative of the waste material.

At each site, two thermocouple strings were installed (string A and string B). String B was installed as a backup in the event of failure of string A. Figure 9 provides a sketch of the thermocouple equipment setup.

A PVC pipe was implanted into the subbase material and used to mount both the datalogger box and solar panel. From the base of the datalogger housing box, thermocouple wires ran down the PVC pipe, through a 3-m-long conduit to the rod with the thermocouple sensors attached, which was inserted into the soil layer to a depth of 910 mm. One conduit was used for each thermocouple string to protect the wires from foot or vehicle damage. The thermocouple string started just below grade, to allow temperature readings at the surface of the soil layer. Hand augers were used to bore the holes into which the thermocouple rods were inserted. Thermocouple sensors were located in 230-mm intervals from the surface to a total depth of 910 mm. The dataloggers recorded hourly temperature changes at each depth. The thermocouple unit operated from battery power,

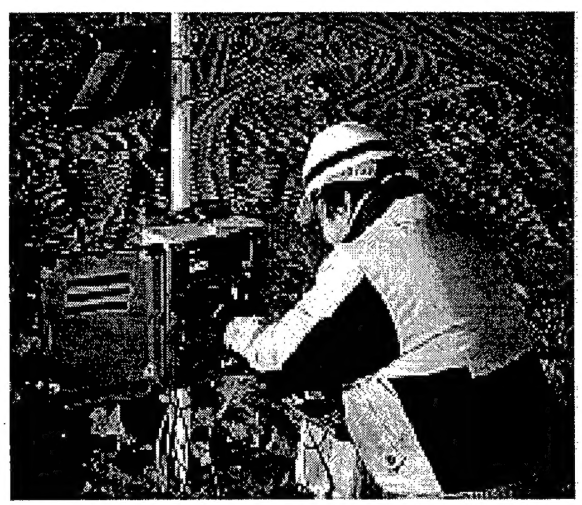


*Figure 10. Datalogger installation.*

**Table 1. Summary of temperature data recorded at all thermocouple sites.**

| *Site* | *Material* | *Date started* | *Data collected up to* | *Total days* |
|---|---|---|---|---|
| 10 | Tilcon | 19 December 1996 | 19 February 1997 | 83 |
| 20 | Tilcon | 19 December 1996 | 19 February 1997 | 83 |
| 30 | J.J. Brennan | 19 December 1996 | 19 February 1997 | 74* |
| 40 | Sand | 8 January 1997 | 19 February 1997 | 62 |

*Note: data were not collected at location 30 from 20 December through 27 December.

and solar panels were used to recharge the batteries. Figure 10 shows the datalogger and the solar panel mounted on the PVC pipe.

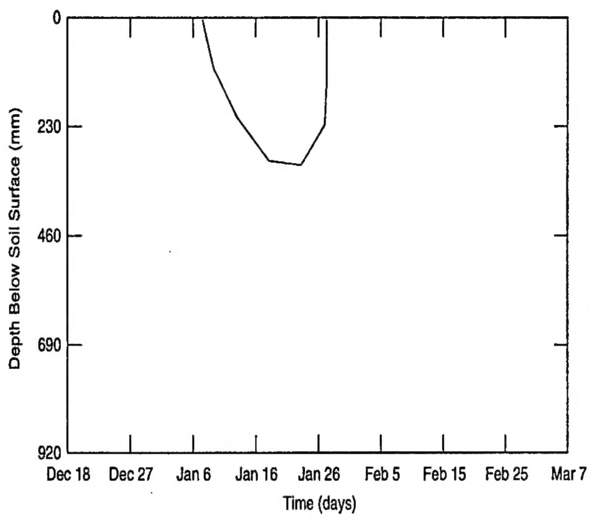
A summary of all the temperature data for each string has been plotted and is provided in Appendix A. Table 1 summarizes the total number of days that temperature data were recorded at each site.

As shown by Table 1, sites 10 and 20 collected 83 days worth of hourly temperatures. The datalogger at site 30 did not work properly between December 20–27 and no data were recorded. A field trip was made to replace a faulty multiplexer board, and temperature data were recorded for the remainder of the testing period. This disruption occurred prior to the frost depth penetrating into the soil and did not affect the data.

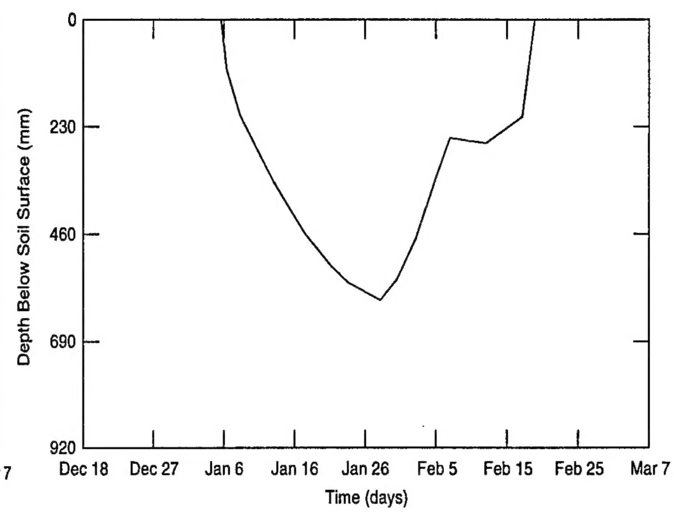
Using temperature, time, and depth, we then mapped the data on a contour plot and the 0°C isotherm was located. This is based on the assumption that the soil present at the Raymark Superfund site freezes at 0°C. This is a workable assumption since fill materials are fairly open materials. After reviewing the data, we selected the daily temperature at 1000 hours for locating the frost depth. There was not a significant difference in the temperature changes when other times of the day were chosen.

The contour plots (Fig. 11) show that frost penetration did occur in all of the materials during a portion of the month of January and February. The contour plots show that the frost depth reached a maximum of approximately 500 mm. Table 2 provides a summary of the maximum frost penetration recorded at the thermocouple sites.

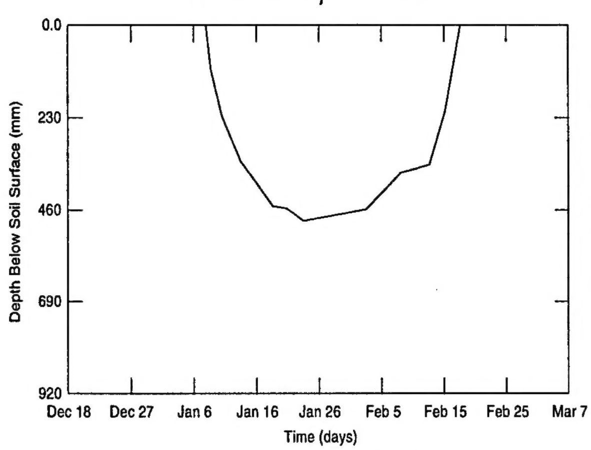
A maximum depth of frost penetration of 230 mm was recorded at site 10. This site was located on a south-facing slope in a relatively sheltered material storage area that inhibited frost penetration.



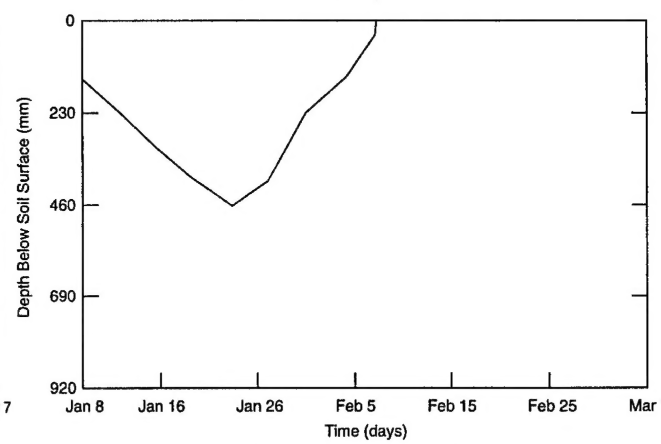

*a. Thermocouple site 10.*




*b. Thermocouple site 20.*




*c. Thermocouple site 30.*




*d. Thermocouple site 40.*

*Figure 11. Estimated frost depth.*

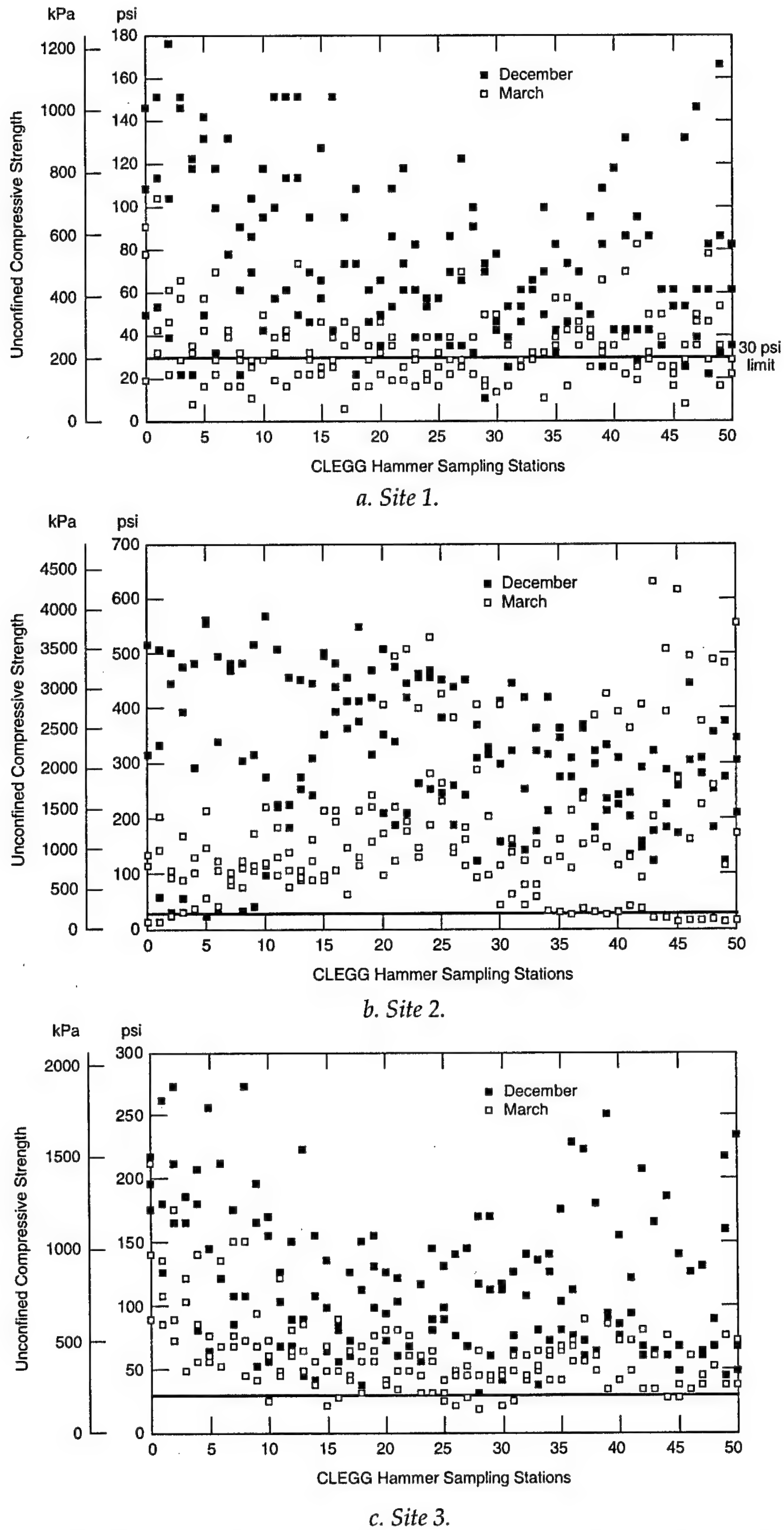
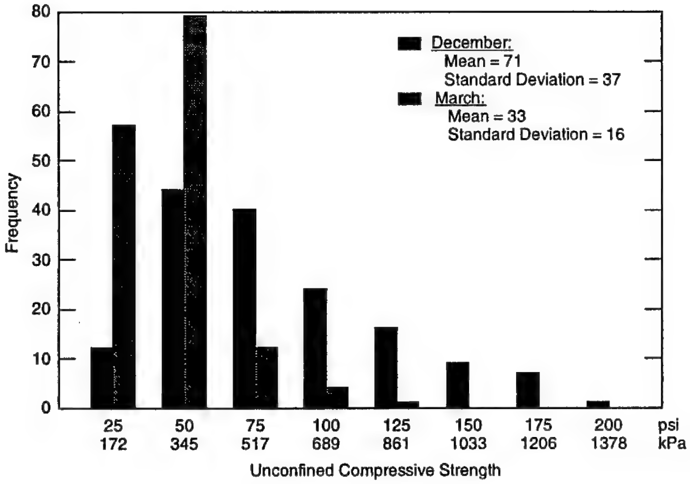
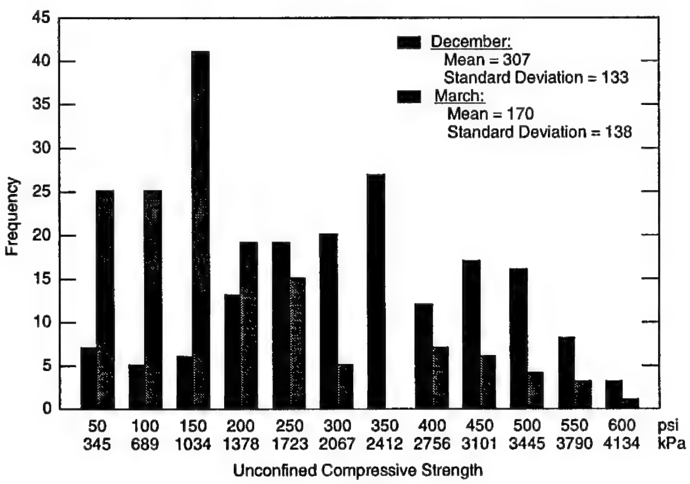


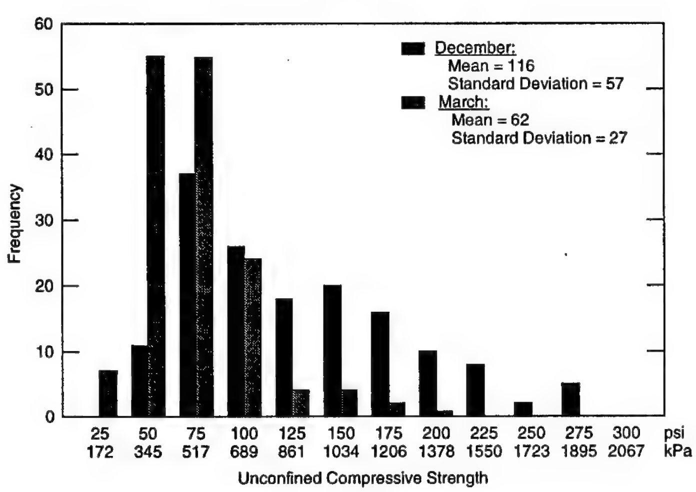

*Figure 12. Variability of unconfined compressive strength for December and March Clegg data.*




*a. Site 1.*




*b. Site 2.*




*a. Site 3.*

*Figure 13. Histograms showing shift in unconfined compressive strength.*

**Table 2. Summary of maximum frost penetration at all thermocouple sites.**

| Thermocouple site | Maximum frost penetration depth (mm) String A | String B |
|---|---|---|
| 10 | 230 | 230 |
| 20 | 510 | 500 |
| 30 | 460 | 460 |
| 40 | 460 | 460 |

## FIELD TESTING DATA ANALYSIS

### Clegg impact hammer results

From information provided by NED, the minimum allowable unconfined compressive strength limit was 30 psi (207 kPa). The unconfined compressive strength values obtained from the Clegg hammer were plotted for each sampling location for both the December and March testing programs. Appendix B contains all of the data from the Clegg hammer tests.

As shown in Figure 12, the unconfined compressive strength of site 1 is variable in December when compared to March. However, most measurements are above the 30-psi limit. In March, the variability is reduced and approximately 50% of the data points fall below the 30-psi limit. Sites 2 and 3 were also both variable in unconfined compressive strength. Both sites showed a reduction in strength from December to March, yet most values still remained above the 30-psi cutoff (Fig. 11b and 11c).

Another way to view the data is by using a histogram for the unconfined compressive strengths for December and March (Fig. 13a–c). Table 3 provides a summary of the statistical data.

For site 1, the mean unconfined compressive strength for the December data are 71 psi (489 kPa) with a standard deviation of 37 psi (255 kPa). Testing results from March yield a mean unconfined compressive strength of 33 psi (227 kPa), a reduction of approximately 50%. The values for the coefficient of variation for Site 1 are 52% and 48% for December and March, respectively. The coefficient of variation is high, and it represents the spatial variability of the strengths found at the site. The March data show that a deterioration of strength occurred during the freezing season.

Site 2 shows a similar downward shift in strength, changing from a range between 250–

Table 3. Summary of Clegg hammer results for unconfined compressive strength.

| | *Mean (kPa)* | | *Standard deviation (kPa)* | | *Coefficient of variation (%)* | |
|---|---|---|---|---|---|---|
| | *December* | *March* | *December* | *March* | *December* | *March* |
| Site 1 | 490 | 228 | 255 | 110 | 52 | 48 |
| Site 2 | 2117 | 1172 | 917 | 952 | 43 | 81 |
| Site 3 | 800 | 428 | 393 | 186 | 49 | 43 |

350 psi (1722–2411 kPa) in December to a range between 50–150 psi (344–1033 kPa) in March. The calculated mean strengths for the December and March tests are 307 and 170 psi (2166 and 1172 kPa), respectively. As observed at site 1, site 2 displays approximately a 50% reduction in strength from December to March. As shown in Table 3, the coefficient of variation increases significantly from 43% in December to 81% in March. Even with the disparity between the coefficient of variation, site 2 showed greater compressive strength values than either sites 1 or 3, and since the values are well above the 30-psi limit, the variation is of little concern.

Site 3 displays the same trend with the greatest number of strengths in December ranging between 75–100 psi (517–689 kPa) and shifting down to 50–75 psi (344–517 kPa) for March. For site 3, the December mean was 116 psi (799 kPa) and the March mean was 62 psi (427 kPa). This again displays approximately a 50% decrease in the mean strength. The coefficient of variation displayed a small change, 49% to 43%, from December to March. It should be noted that even with the substantial range of variation in the statistical values, all testing sites showed the general trend of an overall decrease in strength of 50% over the freezing season.

### DCP results

Using previously discussed eq 1 and 2, we determined that the unconfined compressive strength of 30 psi is approximately equivalent to a CBR of 10. This finding was used to determine the lower limit of CBR 10 for the DCP data, since DCP values are expressed in CBR. This analysis concentrated on four depths below the surface of the material, 150 mm, 230 mm, 305 mm, and 460 mm, to coincide with the depth of frost penetration measured at the site. For each site, a mean CBR value was calculated at each depth. The CBR values obtained at each sampling point were then compared to the mean. The testing in March was performed approximately 150 mm from the locations tested in December to avoid the influence of previous testing.

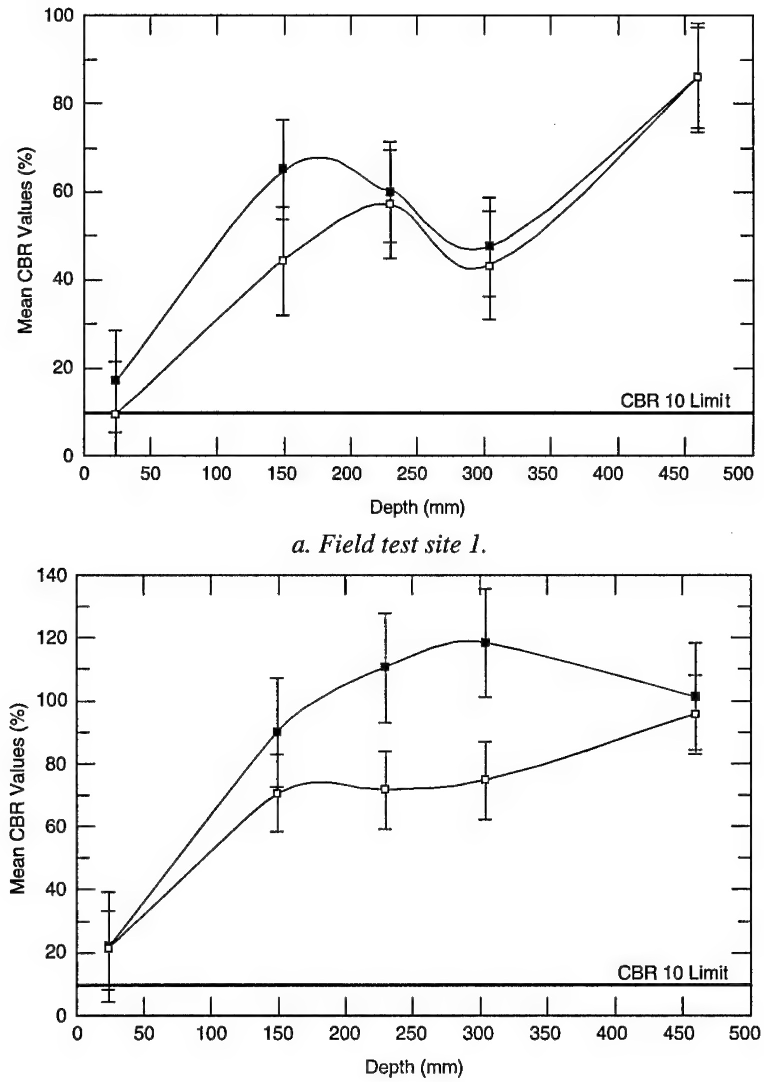
Overall, site 1 (Fig. 14a) showed the greatest reduction in mean CBR values from the surface to a depth of approximately 150 mm. At 305 mm below the surface, the mean CBR values show no significant change between December and March.

Site 3 (Fig. 14b) showed a reduction in the mean CBR values at 150 and 305 mm below the surface. At both depths, the individual CBR values exceed the minimum strength requirement. A summary of the statistical analysis is provided in Appendix C.

## CONCLUSIONS

Based on the Clegg hammer and DCP test results, the overall strength of the stabilized areas was reduced by approximately 50% during the freezing season of 1996–97. However, based on the COE/NED minimum requirement of 30-psi unconfined compressive strength, we found that approximately half of the data from site 1 from March fell below the 30-psi limit based on results from the Clegg hammer tests. The findings from the DCP data show that the mean strength was below 30 psi in approximately the top 50 mm of the structure in the testing areas. NED/EPA should consider the findings from this field study (as well as minimum strength criteria, equipment limitations, and the presence of debris within the soil) when determining the extent of restabilization of the material.

Based on the temperature data measured at the site, frost penetration for the 1996–97 freezing season was approximately 500 mm. Based on the computer simulations run in the first phase of this project, the maximum predicted frost penetration was approximately 500 mm. The predicted frost penetration from the computer simulations correlated very well with temperature measurements from the field. Therefore, the design thickness of 910-mm base cover would be sufficient to prevent frost penetration into the stabilized waste fill.




*a. Field test site 1.*



*b. Field test site 2.*

*Figure 14. Comparison of mean CBR values with depth for December and March.*

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## APPENDIX A: THERMOCOUPLE TEMPERATURE DATA

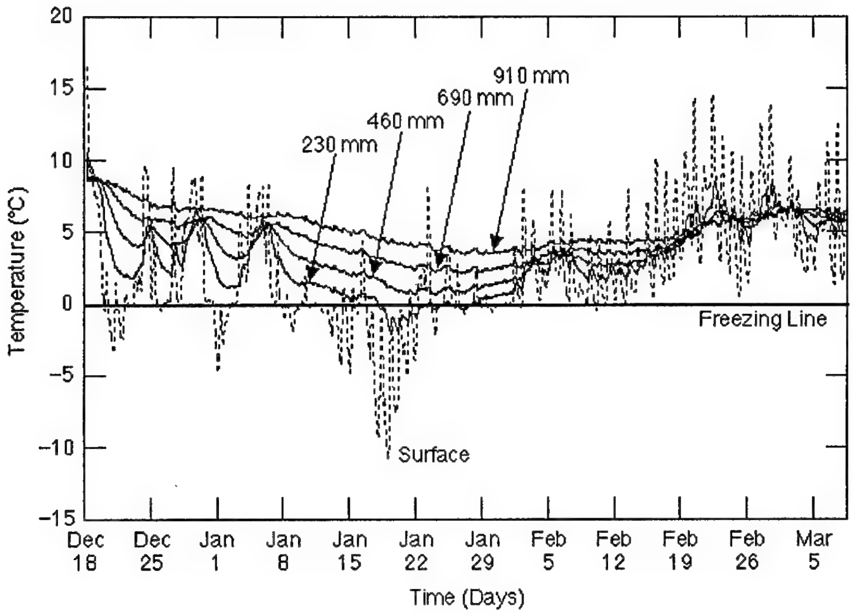


*Figure A1. Site 10, string A.*

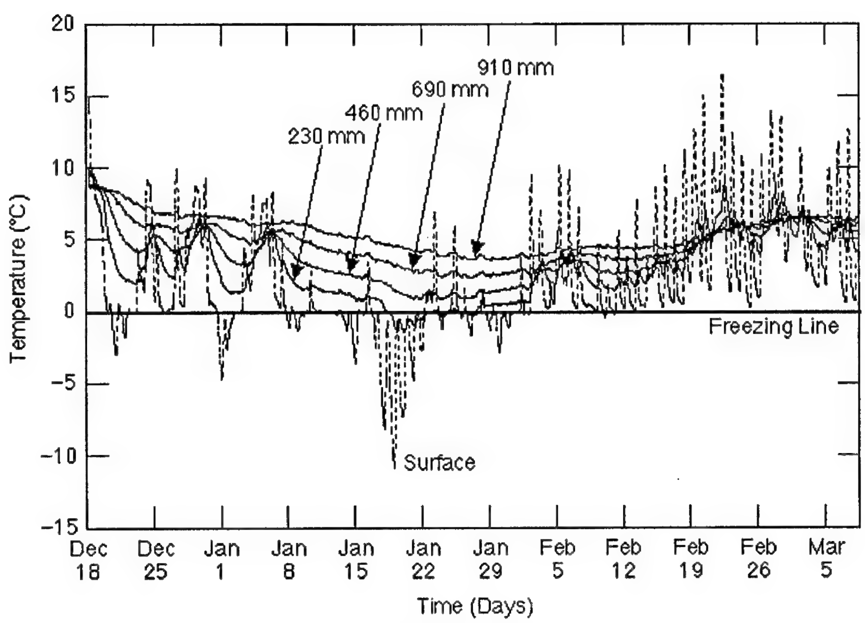


*Figure A2. Site 10, string B.*

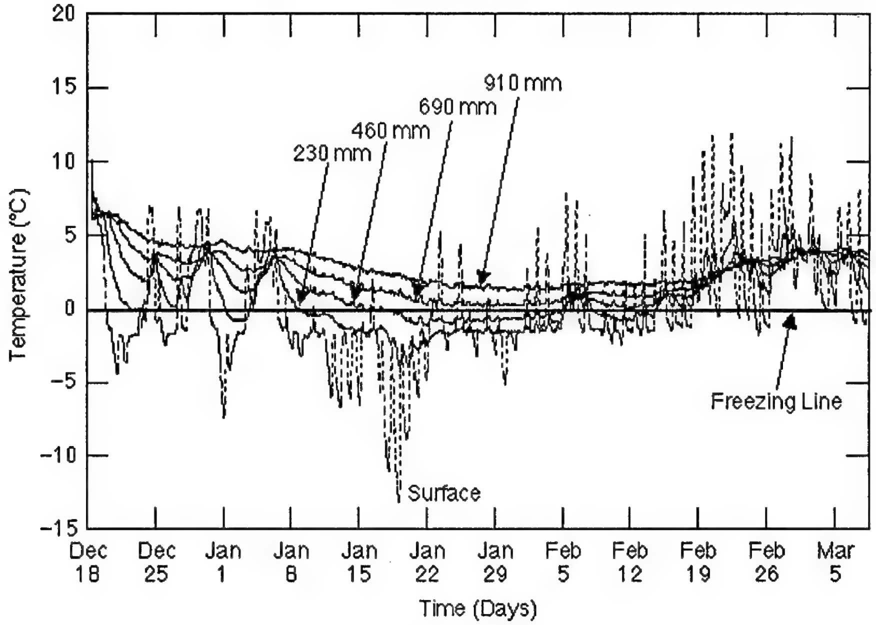


*Figure A3. Site 20, string A.*

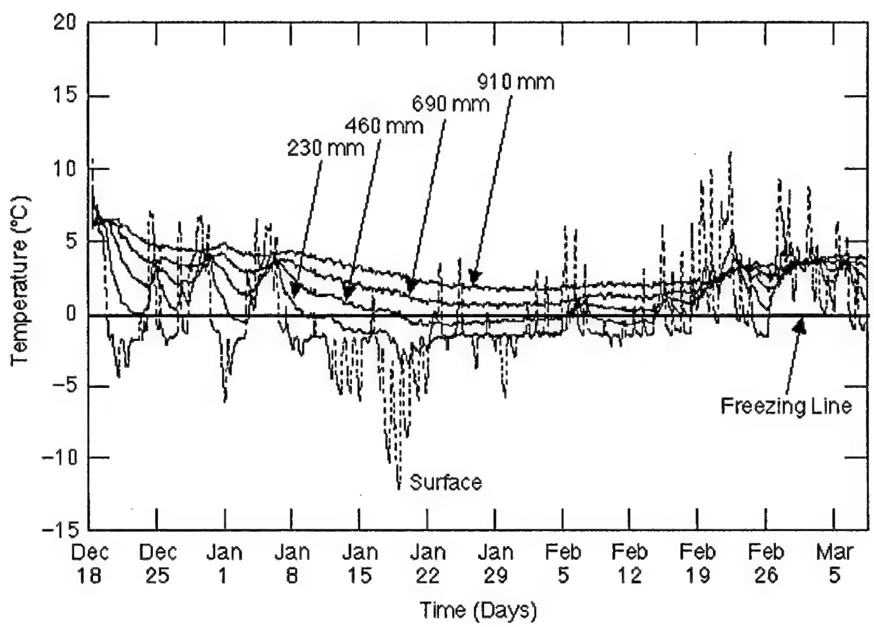


*Figure A4. Site 20, string B.*

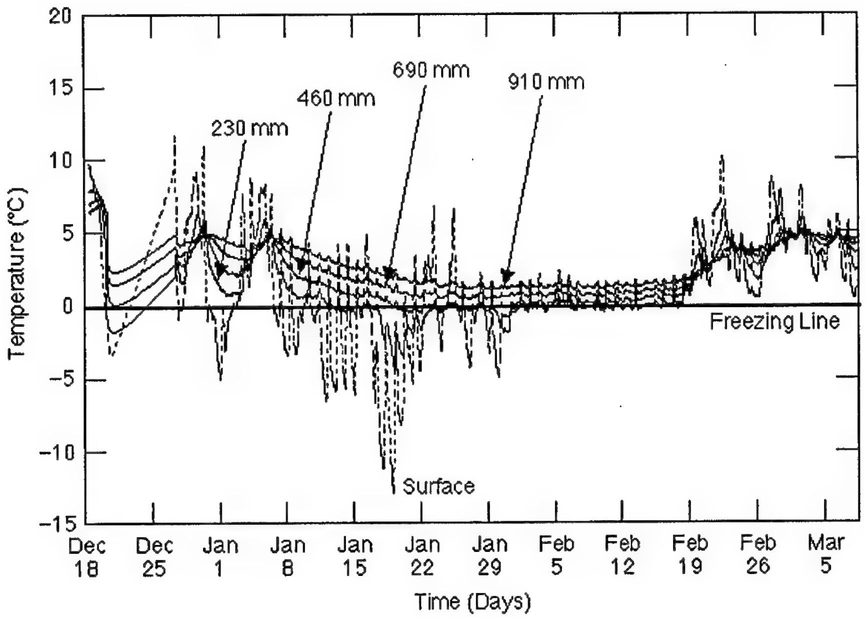


*Figure A5. Site 30, string A.*

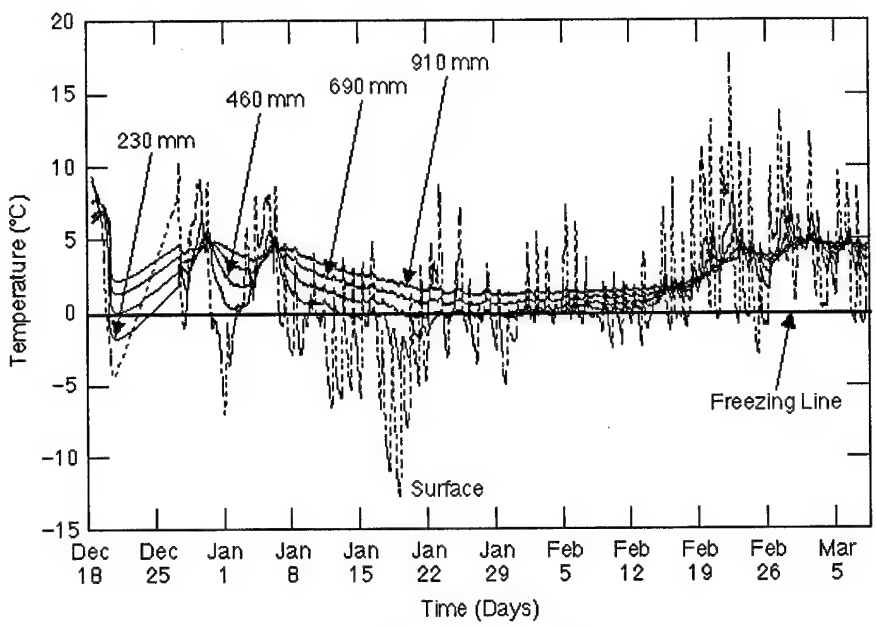


*Figure A6. Site 30, string B.*

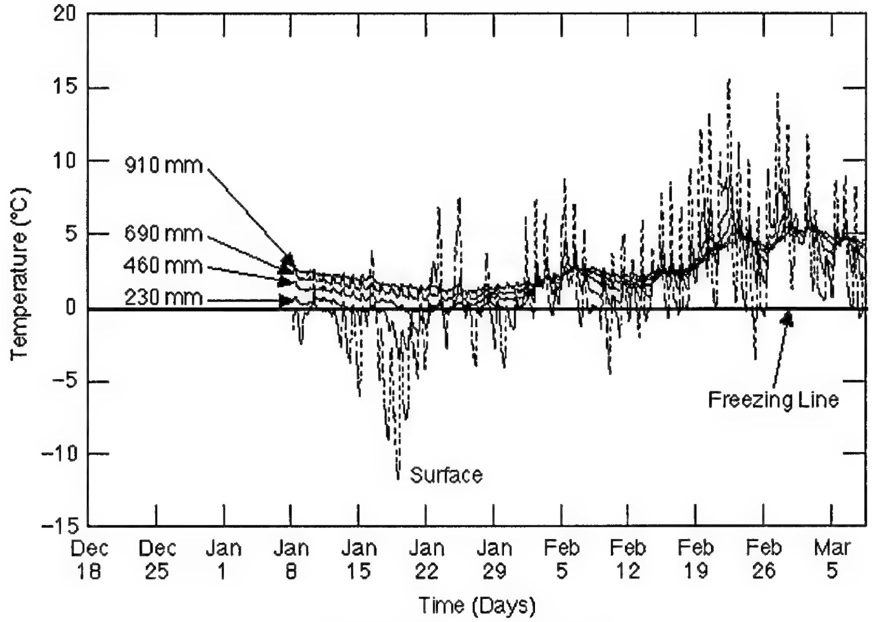


*Figure A7. Site 40, string A.*

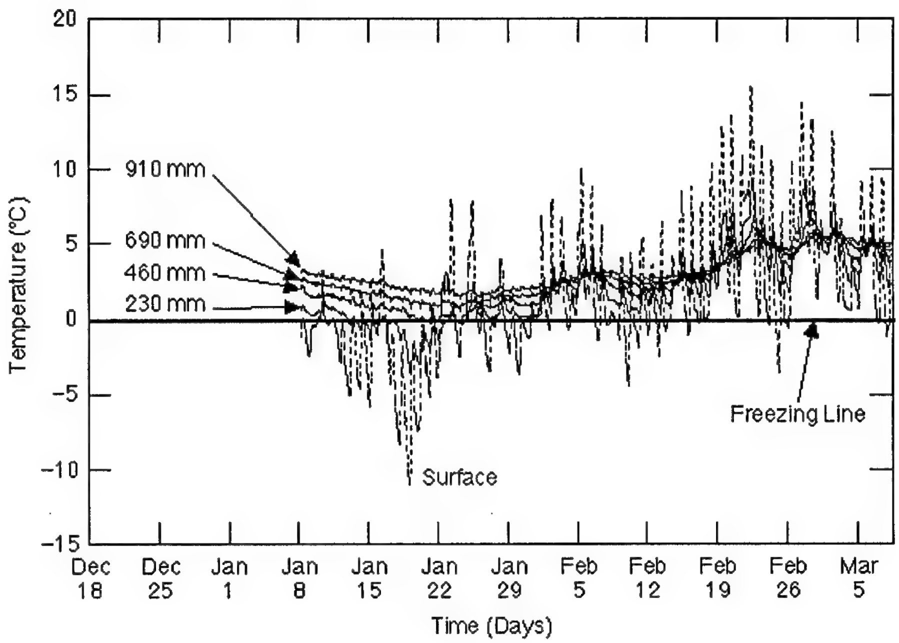


*Figure A8. Site 40, string B.*

## APPENDIX B: CLEGG IMPACT HAMMER DATA

CLEGG HAMMER TESTS DECEMBER Site 1

| Location 1 | Clegg Impact Value (CIV) | | | Compressive Strength (psi) | | |
|---|---|---|---|---|---|---|
| station | WEST | CENTER | EAST | WEST | CENTER | EAST |
| 0+00 | 31 | 17 | 39 | 107.94 | 49.17 | 145.78 |
| 0+01 | 32 | 18 | 40 | 112.52 | 52.98 | 150.69 |
| 0+02 | 45 | 14 | 30 | 175.81 | 38.13 | 103.41 |
| 0+03 | 40 | 9 | 39 | 150.69 | 21.38 | 145.78 |
| 0+04 | 34 | 9 | 33 | 121.82 | 21.38 | 117.15 |
| 0+05 | 36 | 17 | 38 | 131.28 | 49.17 | 140.91 |
| 0+06 | 29 | 12 | 33 | 98.92 | 31.16 | 117.15 |
| 0+07 | 36 | 15 | 24 | 131.28 | 41.74 | 77.21 |
| 0+08 | 27 | 20 | 9 | 90.09 | 60.82 | 21.38 |
| 0+09 | 30 | 26 | 22 | 103.41 | 85.74 | 68.90 |
| 0+10 | 28 | 33 | 15 | 94.48 | 117.15 | 41.74 |
| 0+11 | 29 | 40 | 19 | 98.92 | 150.69 | 56.87 |
| 0+12 | 32 | 40 | 20 | 112.52 | 150.69 | 60.82 |
| 0+13 | 40 | 32 | 17 | 150.69 | 112.52 | 49.17 |
| 0+14 | 28 | 22 | 16 | 94.48 | 68.90 | 45.41 |
| 0+15 | 35 | 21 | 19 | 126.53 | 64.83 | 56.87 |
| 0+16 | 40 | 15 | 15 | 150.69 | 41.74 | 41.74 |
| 0+17 | 28 | 16 | 23 | 94.48 | 45.41 | 73.03 |
| 0+18 | 31 | 9 | 23 | 107.94 | 21.38 | 73.03 |
| 0+19 | 16 | 13 | 20 | 45.41 | 34.61 | 60.82 |
| 0+20 | 21 | 13 | 17 | 64.83 | 34.61 | 49.17 |
| 0+21 | 18 | 26 | 31 | 52.98 | 85.74 | 107.94 |
| 0+22 | 23 | 20 | 33 | 73.03 | 60.82 | 117.15 |
| 0+23 | 20 | 14 | 25 | 60.82 | 38.13 | 81.45 |
| 0+24 | 19 | 9 | 18 | 56.87 | 21.38 | 52.98 |
| 0+25 | 14 | 14 | 19 | 38.13 | 38.13 | 56.87 |
| 0+26 | 22 | 13 | 26 | 68.90 | 34.61 | 85.74 |
| 0+27 | 34 | 13 | 21 | 121.82 | 34.61 | 64.83 |
| 0+28 | 12 | 27 | 29 | 31.16 | 90.09 | 98.92 |
| 0+29 | 5 | 23 | 22 | 9.91 | 73.03 | 68.90 |
| 0+30 | 16 | 15 | 24 | 45.41 | 41.74 | 77.21 |
| 0+31 | 10 | 14 | 18 | 24.55 | 38.13 | 52.98 |
| 0+32 | 18 | 16 | 20 | 52.98 | 45.41 | 60.82 |
| 0+33 | 20 | 21 | 21 | 60.82 | 64.83 | 64.83 |
| 0+34 | 22 | 17 | 29 | 68.90 | 49.17 | 98.92 |
| 0+35 | 12 | 15 | 25 | 31.16 | 41.74 | 81.45 |
| 0+36 | 16 | 23 | 15 | 45.41 | 73.03 | 41.74 |
| 0+37 | 22 | 18 | 16 | 68.90 | 52.98 | 45.41 |
| 0+38 | 17 | 17 | 28 | 49.17 | 49.17 | 94.48 |
| 0+39 | 10 | 25 | 31 | 24.55 | 81.45 | 107.94 |
| 0+40 | 15 | 13 | 33 | 41.74 | 34.61 | 117.15 |
| 0+41 | 15 | 26 | 36 | 41.74 | 85.74 | 131.28 |
| 0+42 | 11 | 15 | 28 | 27.81 | 41.74 | 94.48 |
| 0+43 | 15 | 12 | 26 | 41.74 | 31.16 | 85.74 |
| 0+44 | 13 | 10 | 20 | 34.61 | 24.55 | 60.82 |
| 0+45 | 10 | 18 | 20 | 24.55 | 52.98 | 60.82 |
| 0+46 | 10 | 18 | 36 | 24.55 | 52.98 | 131.28 |
| 0+47 | 14 | 20 | 39 | 38.13 | 60.82 | 145.78 |
| 0+48 | 20 | 9 | 25 | 60.82 | 21.38 | 81.45 |
| 0+49 | 43 | 12 | 26 | 165.66 | 31.16 | 85.74 |
| 0+50 | 25 | 13 | 20 | 81.45 | 34.61 | 60.82 |

**CLEGG HAMMER TESTS** **MARCH** **Site 1**

| **Location 1** | **Clegg Impact Value (CIV)** | | | **Compressive Strength (psi)** | | |
|---|---|---|---|---|---|---|
| station | WEST | CENTER | EAST | WEST | CENTER | EAST |
| 0+00 | 27 | 8 | 24 | 90.09 | 18.33 | 77.21 |
| 0+01 | 30 | 12 | 15 | 103.41 | 131.16 | 41.74 |
| 0+02 | 20 | 9 | 16 | 60.82 | 221.38 | 45.41 |
| 0+03 | 21 | 11 | 19 | 64.83 | 327.81 | 56.87 |
| 0+04 | 12 | 4 | 13 | 31.16 | 67.40 | 34.61 |
| 0+05 | 15 | 7 | 19 | 41.74 | 15.39 | 56.87 |
| 0+06 | 11 | 9 | 22 | 27.81 | 21.38 | 68.90 |
| 0+07 | 15 | 7 | 14 | 41.74 | 15.39 | 38.13 |
| 0+08 | 11 | 7 | 12 | 27.81 | 15.39 | 31.16 |
| 0+09 | 10 | 5 | 11 | 24.55 | 9.91 | 27.81 |
| 0+10 | 11 | 11 | 17 | 27.81 | 27.81 | 49.17 |
| 0+11 | 12 | 14 | 8 | 31.16 | 38.13 | 18.33 |
| 0+12 | 15 | 14 | 7 | 41.74 | 38.13 | 15.39 |
| 0+13 | 23 | 9 | 9 | 73.03 | 21.38 | 21.38 |
| 0+14 | 12 | 9 | 11 | 31.16 | 21.38 | 27.81 |
| 0+15 | 16 | 10 | 9 | 45.41 | 24.55 | 21.38 |
| 0+16 | 14 | 10 | 11 | 38.13 | 24.55 | 27.81 |
| 0+17 | 16 | 3 | 13 | 45.41 | 5.08 | 34.61 |
| 0+18 | 14 | 7 | 15 | 38.13 | 15.39 | 41.74 |
| 0+19 | 11 | 7 | 13 | 27.81 | 15.39 | 34.61 |
| 0+20 | 12 | 9 | 16 | 31.16 | 21.38 | 45.41 |
| 0+21 | 14 | 8 | 13 | 38.13 | 18.33 | 34.61 |
| 0+22 | 10 | 8 | 10 | 24.55 | 18.33 | 24.55 |
| 0+23 | 12 | 7 | 11 | 31.16 | 15.39 | 27.81 |
| 0+24 | 8 | 9 | 14 | 18.33 | 21.38 | 38.13 |
| 0+25 | 7 | 10 | 12 | 15.39 | 24.55 | 31.16 |
| 0+26 | 9 | 14 | 11 | 21.38 | 38.13 | 27.81 |
| 0+27 | 10 | 22 | 11 | 24.55 | 68.90 | 27.81 |
| 0+28 | 9 | 9 | 14 | 21.38 | 21.38 | 38.13 |
| 0+29 | 7 | 8 | 17 | 15.39 | 18.33 | 49.17 |
| 0+30 | 6 | 6 | 17 | 12.58 | 12.58 | 49.17 |
| 0+31 | 7 | 7 | 13 | 15.39 | 15.39 | 34.61 |
| 0+32 | 10 | 10 | 11 | 24.55 | 24.55 | 27.81 |
| 0+33 | 11 | 12 | 11 | 27.81 | 31.16 | 27.81 |
| 0+34 | 5 | 12 | 12 | 9.91 | 31.16 | 31.16 |
| 0+35 | 14 | 13 | 19 | 38.13 | 34.61 | 56.87 |
| 0+36 | 7 | 19 | 15 | 15.39 | 56.87 | 41.74 |
| 0+37 | 13 | 15 | 16 | 34.61 | 41.74 | 45.41 |
| 0+38 | 14 | 10 | 15 | 38.13 | 24.55 | 41.74 |
| 0+39 | 13 | 12 | 21 | 34.61 | 31.16 | 64.83 |
| 0+40 | 10 | 10 | 13 | 24.55 | 24.55 | 34.61 |
| 0+41 | 9 | 14 | 22 | 21.38 | 38.13 | 68.90 |
| 0+42 | 8 | 10 | 25 | 18.33 | 24.55 | 81.45 |
| 0+43 | 11 | 12 | 17 | 27.81 | 31.16 | 49.17 |
| 0+44 | 10 | 14 | 17 | 24.55 | 38.13 | 49.17 |
| 0+45 | 10 | 9 | 7 | 24.55 | 21.38 | 15.39 |
| 0+46 | 11 | 4 | 13 | 27.81 | 7.40 | 34.61 |
| 0+47 | 13 | 17 | 16 | 34.61 | 49.17 | 45.41 |
| 0+48 | 16 | 11 | 24 | 45.41 | 27.81 | 77.21 |
| 0+49 | 13 | 7 | 18 | 34.61 | 15.39 | 52.98 |
| 0+50 | 11 | 11 | 9 | 27.81 | 27.81 | 21.38 |

**CLEGG HAMMER TESTS** **DECEMBER** **Site 2**

| **Location 1** Station | **Clegg Impact Value (CIV)** WEST | CENTER | EAST | **Compressive Strength (psi)** WEST | CENTER | EAST |
|---|---|---|---|---|---|---|
| 0+00 | 70 | 5 | 102 | 313.50 | 9.91 | 513.17 |
| 0+01 | 73 | 19 | 101 | 331.20 | 56.87 | 506.59 |
| 0+02 | 91 | 11 | 100 | 441.96 | 27.81 | 500.03 |
| 0+03 | 83 | 18 | 96 | 391.81 | 52.98 | 474.02 |
| 0+04 | 66 | 12 | 97 | 290.26 | 31.16 | 480.49 |
| 0+05 | 108 | 9 | 109 | 553.03 | 21.38 | 559.75 |
| 0+06 | 74 | 13 | 99 | 337.15 | 34.61 | 493.50 |
| 0+07 | 95 | 28 | 97 | 467.56 | 94.48 | 480.49 |
| 0+08 | 68 | 12 | 97 | 301.82 | 31.16 | 480.49 |
| 0+09 | 70 | 14 | 102 | 313.50 | 38.13 | 513.17 |
| 0+10 | 63 | 28 | 110 | 273.11 | 94.48 | 566.48 |
| 0+11 | 54 | 53 | 101 | 223.20 | 217.81 | 506.59 |
| 0+12 | 54 | 46 | 93 | 223.20 | 180.95 | 454.72 |
| 0+13 | 63 | 59 | 92 | 273.11 | 250.64 | 448.33 |
| 0+14 | 69 | 57 | 91 | 307.65 | 239.57 | 441.96 |
| 0+15 | 76 | 100 | 99 | 349.13 | 500.03 | 493.50 |
| 0+16 | 83 | 90 | 97 | 391.81 | 435.62 | 480.49 |
| 0+17 | 78 | 86 | 93 | 361.20 | 410.45 | 454.72 |
| 0+18 | 86 | 80 | 107 | 410.45 | 373.37 | 546.34 |
| 0+19 | 70 | 87 | 95 | 313.50 | 416.71 | 467.56 |
| 0+20 | 51 | 76 | 101 | 207.11 | 349.13 | 506.59 |
| 0+21 | 47 | 74 | 96 | 186.11 | 337.15 | 474.02 |
| 0+22 | 51 | 87 | 91 | 207.11 | 416.71 | 441.96 |
| 0+23 | 61 | 93 | 94 | 261.82 | 454.72 | 461.13 |
| 0+24 | 59 | 93 | 95 | 250.64 | 454.72 | 467.56 |
| 0+25 | 58 | 81 | 92 | 245.09 | 379.50 | 448.33 |
| 0+26 | 47 | 60 | 90 | 186.11 | 256.21 | 435.62 |
| 0+27 | 57 | 46 | 92 | 239.57 | 180.95 | 448.33 |
| 0+28 | 34 | 69 | 79 | 121.82 | 307.65 | 367.28 |
| 0+29 | 28 | 70 | 72 | 94.48 | 313.50 | 325.27 |
| 0+30 | 41 | 67 | 86 | 155.64 | 296.03 | 410.45 |
| 0+31 | 40 | 71 | 91 | 150.69 | 319.37 | 441.96 |
| 0+32 | 38 | 59 | 87 | 140.91 | 250.64 | 416.71 |
| 0+33 | 45 | 71 | 78 | 175.81 | 319.37 | 361.20 |
| 0+34 | 52 | 87 | 70 | 212.45 | 416.71 | 313.50 |
| 0+35 | 63 | 75 | 78 | 273.11 | 343.13 | 361.20 |
| 0+36 | 63 | 63 | 69 | 273.11 | 273.11 | 307.65 |
| 0+37 | 78 | 58 | 79 | 361.20 | 245.09 | 367.28 |
| 0+38 | 71 | 46 | 67 | 319.37 | 180.95 | 296.03 |
| 0+39 | 56 | 52 | 73 | 234.09 | 212.45 | 331.20 |
| 0+40 | 57 | 54 | 69 | 239.57 | 223.20 | 307.65 |
| 0+41 | 50 | 36 | 58 | 201.81 | 131.28 | 245.09 |
| 0+42 | 39 | 41 | 66 | 145.78 | 155.64 | 290.26 |
| 0+43 | 45 | 34 | 71 | 175.81 | 121.82 | 319.37 |
| 0+44 | 46 | 54 | 65 | 180.95 | 223.20 | 284.51 |
| 0+45 | 44 | 60 | 63 | 170.72 | 256.21 | 273.11 |
| 0+46 | 68 | 91 | 68 | 301.82 | 441.96 | 301.82 |
| 0+47 | 54 | 69 | 64 | 223.20 | 307.65 | 278.80 |
| 0+48 | 46 | 77 | 59 | 180.95 | 355.15 | 250.64 |
| 0+49 | 34 | 80 | 63 | 121.82 | 373.37 | 273.11 |
| 0+50 | 51 | 75 | 68 | 207.11 | 343.13 | 301.82 |

**CLEGG HAMMER TESTS** **MARCH Site 2**

| Location 1 | Clegg Impact Value (CIV) | | | Compressive Strength (psi) | | |
|---|---|---|---|---|---|---|
| station | WEST | CENTER | EAST | WEST | CENTER | EAST |
| 0+00 | 32 | 5 | 36 | 112.52 | 9.91 | 131.28 |
| 0+01 | 50 | 5 | 38 | 201.81 | 9.91 | 140.91 |
| 0+02 | 27 | 9 | 30 | 90.09 | 21.38 | 103.41 |
| 0+03 | 43 | 11 | 26 | 165.66 | 27.81 | 85.74 |
| 0+04 | 29 | 13 | 35 | 98.92 | 34.61 | 126.53 |
| 0+05 | 52 | 18 | 39 | 212.45 | 52.98 | 145.78 |
| 0+06 | 34 | 14 | 30 | 121.82 | 38.13 | 103.41 |
| 0+07 | 29 | 24 | 26 | 98.92 | 77.21 | 85.74 |
| 0+08 | 34 | 23 | 31 | 121.82 | 73.03 | 107.94 |
| 0+09 | 30 | 32 | 44 | 103.41 | 112.52 | 170.72 |
| 0+10 | 53 | 32 | 33 | 217.81 | 112.52 | 117.15 |
| 0+11 | 46 | 28 | 35 | 180.95 | 94.48 | 126.53 |
| 0+12 | 23 | 30 | 37 | 73.03 | 103.41 | 136.07 |
| 0+13 | 26 | 30 | 27 | 85.74 | 103.41 | 90.09 |
| 0+14 | 26 | 34 | 42 | 85.74 | 121.82 | 160.63 |
| 0+15 | 26 | 28 | 52 | 85.74 | 94.48 | 212.45 |
| 0+16 | 30 | 48 | 52 | 103.41 | 191.31 | 212.45 |
| 0+17 | 39 | 20 | 39 | 145.78 | 60.82 | 145.78 |
| 0+18 | 35 | 52 | 32 | 126.53 | 212.45 | 112.52 |
| 0+19 | 53 | 41 | 57 | 217.81 | 155.64 | 239.57 |
| 0+20 | 28 | 44 | 85 | 94.48 | 170.72 | 404.21 |
| 0+21 | 34 | 53 | 99 | 121.82 | 217.81 | 493.50 |
| 0+22 | 45 | 48 | 101 | 175.81 | 191.31 | 506.59 |
| 0+23 | 39 | 35 | 84 | 145.78 | 126.53 | 398.00 |
| 0+24 | 64 | 47 | 104 | 278.80 | 186.11 | 526.38 |
| 0+25 | 61 | 55 | 88 | 261.82 | 228.63 | 422.99 |
| 0+26 | 37 | 39 | 81 | 136.07 | 145.78 | 379.50 |
| 0+27 | 32 | 42 | 46 | 112.52 | 160.63 | 180.95 |
| 0+28 | 27 | 85 | 65 | 90.09 | 404.21 | 284.51 |
| 0+29 | 50 | 28 | 28 | 201.81 | 94.48 | 94.48 |
| 0+30 | 85 | 15 | 32 | 404.21 | 41.74 | 112.52 |
| 0+31 | 42 | 20 | 37 | 160.63 | 60.82 | 136.07 |
| 0+32 | 24 | 15 | 34 | 77.21 | 41.74 | 121.82 |
| 0+33 | 24 | 19 | 40 | 77.21 | 56.87 | 150.69 |
| 0+34 | 34 | 12 | 34 | 121.82 | 31.16 | 121.82 |
| 0+35 | 42 | 11 | 35 | 160.63 | 27.81 | 126.53 |
| 0+36 | 31 | 10 | 52 | 107.94 | 24.55 | 212.45 |
| 0+37 | 40 | 13 | 56 | 150.69 | 34.61 | 234.09 |
| 0+38 | 42 | 11 | 82 | 160.63 | 27.81 | 385.64 |
| 0+39 | 39 | 10 | 88 | 145.78 | 24.55 | 422.99 |
| 0+40 | 32 | 11 | 83 | 112.52 | 27.81 | 391.81 |
| 0+41 | 35 | 14 | 78 | 126.53 | 38.13 | 361.20 |
| 0+42 | 27 | 13 | 85 | 90.09 | 34.61 | 404.21 |
| 0+43 | 50 | 8 | 119 | 201.81 | 18.33 | 627.90 |
| 0+44 | 83 | 8 | 101 | 391.81 | 18.33 | 506.59 |
| 0+45 | 62 | 5 | 117 | 267.45 | 9.91 | 614.12 |
| 0+46 | 42 | 6 | 99 | 160.63 | 12.58 | 493.50 |
| 0+47 | 54 | 6 | 80 | 223.20 | 12.58 | 373.37 |
| 0+48 | 60 | 7 | 98 | 256.21 | 15.39 | 486.98 |
| 0+49 | 32 | 5 | 97 | 112.52 | 9.91 | 480.49 |
| 0+50 | 44 | 6 | 108 | 170.72 | 12.58 | 553.03 |

| CLEGG HAMMER TESTS | | | | DECEMBER | | Site 3 |
|---|---|---|---|---|---|---|
| **Location 1** | **Clegg Impact Value (CIV)** | | | **Compressive Strength (psi)** | | |
| station | NORTH | CENTER | SOUTH | NORTH | CENTER | SOUTH |
| 0+00 | 49 | 45 | 53 | 196.55 | 175.81 | 217.81 |
| 0+01 | 35 | 46 | 61 | 126.53 | 180.95 | 261.82 |
| 0+02 | 52 | 43 | 63 | 212.45 | 165.66 | 273.11 |
| 0+03 | 43 | 47 | 43 | 165.66 | 186.11 | 165.66 |
| 0+04 | 46 | 25 | 51 | 180.95 | 81.45 | 207.11 |
| 0+05 | 21 | 39 | 60 | 64.83 | 145.78 | 256.21 |
| 0+06 | 34 | 34 | 52 | 121.82 | 121.82 | 212.45 |
| 0+07 | 45 | 31 | 26 | 175.81 | 107.94 | 85.74 |
| 0+08 | 40 | 31 | 63 | 150.69 | 107.94 | 273.11 |
| 0+09 | 43 | 18 | 49 | 165.66 | 52.98 | 196.55 |
| 0+10 | 41 | 19 | 44 | 155.64 | 56.87 | 170.72 |
| 0+11 | 30 | 22 | 35 | 103.41 | 68.90 | 126.53 |
| 0+12 | 27 | 22 | 40 | 90.09 | 68.90 | 150.69 |
| 0+13 | 27 | 16 | 54 | 90.09 | 45.41 | 223.20 |
| 0+14 | 31 | 15 | 41 | 107.94 | 41.74 | 155.64 |
| 0+15 | 29 | 21 | 37 | 98.92 | 64.83 | 136.07 |
| 0+16 | 19 | 26 | 25 | 56.87 | 85.74 | 81.45 |
| 0+17 | 23 | 20 | 35 | 73.03 | 60.82 | 126.53 |
| 0+18 | 32 | 14 | 40 | 112.52 | 38.13 | 150.69 |
| 0+19 | 41 | 36 | 29 | 155.64 | 131.28 | 98.92 |
| 0+20 | 28 | 23 | 35 | 94.48 | 73.03 | 126.53 |
| 0+21 | 30 | 20 | 34 | 103.41 | 60.82 | 121.82 |
| 0+22 | 22 | 24 | 17 | 68.90 | 77.21 | 49.17 |
| 0+23 | 33 | 20 | 19 | 117.15 | 60.82 | 56.87 |
| 0+24 | 39 | 27 | 25 | 145.78 | 90.09 | 81.45 |
| 0+25 | 36 | 27 | 29 | 131.28 | 90.09 | 98.92 |
| 0+26 | 38 | 24 | 38 | 140.91 | 77.21 | 140.91 |
| 0+27 | 39 | 18 | 22 | 145.78 | 52.98 | 68.90 |
| 0+28 | 44 | 12 | 33 | 170.72 | 31.16 | 117.15 |
| 0+29 | 44 | 20 | 32 | 170.72 | 60.82 | 112.52 |
| 0+30 | 32 | 15 | 33 | 112.52 | 41.74 | 117.15 |
| 0+31 | 21 | 24 | 35 | 64.83 | 77.21 | 126.53 |
| 0+32 | 20 | 31 | 38 | 60.82 | 107.94 | 140.91 |
| 0+33 | 14 | 25 | 37 | 38.13 | 81.45 | 136.07 |
| 0+34 | 38 | 35 | 23 | 140.91 | 126.53 | 73.03 |
| 0+35 | 45 | 25 | 30 | 175.81 | 81.45 | 103.41 |
| 0+36 | 55 | 24 | 32 | 228.63 | 77.21 | 112.52 |
| 0+37 | 54 | 20 | 23 | 223.20 | 60.82 | 73.03 |
| 0+38 | 46 | 21 | 20 | 180.95 | 64.83 | 60.82 |
| 0+39 | 59 | 28 | 27 | 250.64 | 94.48 | 90.09 |
| 0+40 | 41 | 24 | 26 | 155.64 | 77.21 | 85.74 |
| 0+41 | 34 | 28 | 23 | 121.82 | 94.48 | 73.03 |
| 0+42 | 51 | 22 | 20 | 207.11 | 68.90 | 60.82 |
| 0+43 | 43 | 20 | 21 | 165.66 | 60.82 | 64.83 |
| 0+44 | 47 | 20 | 24 | 186.11 | 60.82 | 77.21 |
| 0+45 | 38 | 17 | 22 | 140.91 | 49.17 | 68.90 |
| 0+46 | 35 | 13 | 20 | 126.53 | 34.61 | 60.82 |
| 0+47 | 36 | 20 | 21 | 131.28 | 60.82 | 64.83 |
| 0+48 | 27 | 18 | 22 | 90.09 | 52.98 | 68.90 |
| 0+49 | 53 | 42 | 16 | 217.81 | 160.63 | 45.41 |
| 0+50 | 56 | 17 | 22 | 234.09 | 49.17 | 68.90 |

| CLEGG HAMMER TESTS | | | | MARCH | | Site 3 |
|---|---|---|---|---|---|---|
| **Location 1** | **Clegg Impact Value (CIV)** | | | **Compressive Strength (psi)** | | |
| station | NORTH | CENTER | SOUTH | NORTH | CENTER | SOUTH |
| 0+00 | 52 | 27 | 38 | 212.45 | 90.09 | 140.91 |
| 0+01 | 37 | 26 | 31 | 136.07 | 85.74 | 107.94 |
| 0+02 | 45 | 23 | 27 | 175.81 | 73.03 | 90.09 |
| 0+03 | 34 | 17 | 30 | 121.82 | 49.17 | 103.41 |
| 0+04 | 38 | 26 | 19 | 140.91 | 85.74 | 56.87 |
| 0+05 | 24 | 19 | 20 | 77.21 | 56.87 | 60.82 |
| 0+06 | 37 | 18 | 22 | 136.07 | 52.98 | 68.90 |
| 0+07 | 40 | 22 | 24 | 150.69 | 68.90 | 77.21 |
| 0+08 | 40 | 16 | 23 | 150.69 | 45.41 | 73.03 |
| 0+09 | 28 | 15 | 22 | 94.48 | 41.74 | 68.90 |
| 0+10 | 20 | 10 | 23 | 60.82 | 24.55 | 73.03 |
| 0+11 | 34 | 17 | 16 | 121.82 | 49.17 | 45.41 |
| 0+12 | 20 | 25 | 21 | 60.82 | 81.45 | 64.83 |
| 0+13 | 21 | 17 | 26 | 64.83 | 49.17 | 85.74 |
| 0+14 | 19 | 14 | 19 | 56.87 | 38.13 | 56.87 |
| 0+15 | 22 | 9 | 17 | 68.90 | 21.38 | 49.17 |
| 0+16 | 17 | 11 | 27 | 49.17 | 27.81 | 90.09 |
| 0+17 | 16 | 15 | 21 | 45.41 | 41.74 | 64.83 |
| 0+18 | 19 | 12 | 22 | 56.87 | 31.16 | 68.90 |
| 0+19 | 24 | 19 | 21 | 77.21 | 56.87 | 64.83 |
| 0+20 | 25 | 15 | 14 | 81.45 | 41.74 | 38.13 |
| 0+21 | 25 | 13 | 17 | 81.45 | 34.61 | 49.17 |
| 0+22 | 24 | 17 | 20 | 77.21 | 49.17 | 60.82 |
| 0+23 | 20 | 16 | 12 | 60.82 | 45.41 | 31.16 |
| 0+24 | 21 | 19 | 12 | 64.83 | 56.87 | 31.16 |
| 0+25 | 15 | 12 | 10 | 41.74 | 31.16 | 24.55 |
| 0+26 | 17 | 9 | 16 | 49.17 | 21.38 | 45.41 |
| 0+27 | 18 | 11 | 16 | 52.98 | 27.81 | 45.41 |
| 0+28 | 16 | 8 | 21 | 45.41 | 18.33 | 64.83 |
| 0+29 | 15 | 16 | 16 | 41.74 | 45.41 | 45.41 |
| 0+30 | 17 | 9 | 16 | 49.17 | 21.38 | 45.41 |
| 0+31 | 20 | 10 | 17 | 60.82 | 24.55 | 49.17 |
| 0+32 | 15 | 16 | 20 | 41.74 | 45.41 | 60.82 |
| 0+33 | 21 | 17 | 18 | 64.83 | 49.17 | 52.98 |
| 0+34 | 20 | 15 | 21 | 60.82 | 41.74 | 64.83 |
| 0+35 | 21 | 15 | 22 | 64.83 | 41.74 | 68.90 |
| 0+36 | 22 | 19 | 23 | 68.90 | 56.87 | 73.03 |
| 0+37 | 27 | 27 | 19 | 90.09 | 90.09 | 56.87 |
| 0+38 | 20 | 20 | 17 | 60.82 | 60.82 | 49.17 |
| 0+39 | 26 | 26 | 13 | 85.74 | 85.74 | 34.61 |
| 0+40 | 23 | 23 | 15 | 73.03 | 73.03 | 41.74 |
| 0+41 | 23 | 23 | 17 | 73.03 | 73.03 | 49.17 |
| 0+42 | 25 | 25 | 13 | 81.45 | 81.45 | 34.61 |
| 0+43 | 20 | 20 | 13 | 60.82 | 60.82 | 34.61 |
| 0+44 | 24 | 24 | 11 | 77.21 | 77.21 | 27.81 |
| 0+45 | 14 | 14 | 11 | 38.13 | 38.13 | 27.81 |
| 0+46 | 20 | 20 | 13 | 60.82 | 60.82 | 34.61 |
| 0+47 | 16 | 16 | 14 | 45.41 | 45.41 | 38.13 |
| 0+48 | 18 | 18 | 18 | 52.98 | 52.98 | 52.98 |
| 0+49 | 24 | 24 | 14 | 77.21 | 77.21 | 38.13 |
| 0+50 | 23 | 23 | 14 | 73.03 | 73.03 | 38.13 |

## APPENDIX C: DCP DATA

| *Site 1, Surface (Dec)* | |
|---|---|
| Mean | 17.021212 |
| Standard Error | 2.0403541 |
| Median | 14.1 |
| Mode | 11.8 |
| Standard Deviation | 11.720942 |
| Sample Variance | 137.38047 |
| Kurtosis | 0.9604239 |
| Skewness | 1.2656336 |
| Range | 43.4 |
| Minimum | 4.7 |
| Maximum | 48.1 |
| Sum | 561.7 |
| Count | 33 |
| Confidence Level(95.0%) | 4.1560617 |

| *Site 1,Surface (March)* | |
|---|---|
| Mean | 9.240303031 |
| Standard Error | 1.101501943 |
| Median | 6.47 |
| Mode | 6.47 |
| Standard Deviation | 6.32764691 |
| Sample Variance | 40.03911553 |
| Kurtosis | 3.770051247 |
| Skewness | 1.819055542 |
| Range | 28.98 |
| Minimum | 1.58999999 |
| Maximum | 30.5699999 |
| Sum | 304.93 |
| Count | 33 |
| Confidence Level(95.000%) | 2.158900941 |

| *Site 1, 6 inches (Dec)* | |
|---|---|
| Mean | 65.042424 |
| Standard Error | 5.8499353 |
| Median | 57.2 |
| Mode | 61.8 |
| Standard Deviation | 33.60531: |
| Sample Variance | 1129.3175 |
| Kurtosis | 0.9658905 |
| Skewness | 0.9815129 |
| Range | 147.5 |
| Minimum | 17.3 |
| Maximum | 164.8 |
| Sum | 2146.4 |
| Count | 33 |
| Confidence Level(95.0%) | 11.915918 |

| *Site 1,6 inches (March)* | |
|---|---|
| Mean | 44.15 |
| Standard Error | 4.50461078 |
| Median | 39.25 |
| Mode | 39.25 |
| Standard Deviation | 25.87701888 |
| Sample Variance | 669.6201062 |
| Kurtosis | 0.853964902 |
| Skewness | 1.041687556 |
| Range | 109.39 |
| Minimum | 3.650000001 |
| Maximum | 113.04 |
| Sum | 1456.95 |
| Count | 33 |
| Confidence Level(95.000%) | 8.82886183 |

| *Site 1, 9 inches (Dec)* | |
|---|---|
| Mean | 59.818182 |
| Standard Error | 5.589161 |
| Median | 48.1 |
| Mode | 30.6 |
| Standard Deviation | 32.107286 |
| Sample Variance | 1030.8778 |
| Kurtosis | 1.2306569 |
| Skewness | 1.2586884 |
| Range | 135.2 |
| Minimum | 17.3 |
| Maximum | 152.5 |
| Sum | 1974 |
| Count | 33 |
| Confidence Level(95.0%) | 11.384739 |

| *Site 1, 9 inches (March)* | |
|---|---|
| Mean | 57.09393939 |
| Standard Error | 6.125933663 |
| Median | 48.1 |
| Mode | 48.1 |
| Standard Deviation | 35.1908097 |
| Sample Variance | 1238.393087 |
| Kurtosis | 0.901098603 |
| Skewness | 1.106429616 |
| Range | 146.7 |
| Minimum | 9.3 |
| Maximum | 156 |
| Sum | 1884.1 |
| Count | 33 |
| Confidence Level(95.0%) | 12.47810797 |

| *Site 1, 12 inches (Dec)* | |
|---|---|
| Mean | 47.390625 |
| Standard Error | 5.4883847 |
| Median | 38.4 |
| Mode | 27.2 |
| Standard Deviation | 31.046992 |
| Sample Variance | 963.91572 |
| Kurtosis | 7.4120506 |
| Skewness | 2.61998 |
| Range | 142.1 |
| Minimum | 20.4 |
| Maximum | 162.5 |
| Sum | 1516.5 |
| Count | 32 |
| Confidence Level(95.0%) | 11.193641 |

| *Site 1,12 inches (March)* | |
|---|---|
| Mean | 43.05090909 |
| Standard Error | 4.042469626 |
| Median | 37.5 |
| Mode | 22.15 |
| Standard Deviation | 23.22222001 |
| Sample Variance | 539.2715023 |
| Kurtosis | 0.034615909 |
| Skewness | 0.803195649 |
| Range | 92.8 |
| Minimum | 11.84 |
| Maximum | 104.64 |
| Sum | 1420.68 |
| Count | 33 |
| Confidence Level(95.000%) | 7.923083144 |

| Site 1, 18 inches (Dec) | |
|---|---|
| Mean | 85.875862 |
| Standard Error | 12.607044 |
| Median | 71.8 |
| Mode | 71.8 |
| Standard Deviation | 67.891009 |
| Sample Variance | 4609.189 |
| Kurtosis | 6.49938 |
| Range | 307.6 |
| Minimum | 23.9 |
| Maximum | 331.5 |
| Sum | 2490.4 |
| Count | 29 |
| Confidence Level(95.0%) | 25.824388 |

| Site 1,18 inches (March) | |
|---|---|
| Mean | 85.72878788 |
| Standard Error | 11.03500524 |
| Median | 66.45 |
| Mode | 85.31 |
| Standard Deviation | 63.39127891 |
| Sample Variance | 4018.454242 |
| Kurtosis | 10.02494028 |
| Range | 336 |
| Minimum | 22.15 |
| Maximum | 358.15 |
| Sum | 2829.05 |
| Count | 33 |
| Confidence Level(95.000%) | 21.62818082 |

| Site 3, Surface (Dec) | |
|---|---|
| Mean | 22.160606 |
| Standard Error | 2.206713 |
| Median | 18.6 |
| Mode | 27.2 |
| Standard Deviation | 12.676601 |
| Sample Variance | 160.69621 |
| Kurtosis | 4.6697602 |
| Skewness | 1.8218327 |
| Range | 60.8 |
| Minimum | 5.6 |
| Maximum | 66.4 |
| Sum | 731.3 |
| Count | 33 |
| Confidence Level(95.0%) | 4.4949234 |

| Site 3,Surface (March) | |
|---|---|
| Mean | 21.04757576 |
| Standard Error | 2.21469896 |
| Median | 18.64 |
| Mode | 27.17 |
| Standard Deviation | 12.72247692 |
| Sample Variance | 161.8614189 |
| Kurtosis | 0.193894639 |
| Skewness | 0.822932227 |
| Range | 48.72 |
| Minimum | 5.45 |
| Maximum | 54.17 |
| Sum | 694.57 |
| Count | 33 |
| Confidence Level(95.000%) | 4.34072376 |

| Site 3, 6 inches (Dec) | |
|---|---|
| Mean | 89.848485 |
| Standard Error | 10.720748 |
| Median | 61.8 |
| Mode | 48.1 |
| Standard Deviation | 61.586008 |
| Sample Variance | 3792.8363 |
| Kurtosis | -0.3042073 |
| Skewness | 1.0689974 |
| Range | 210.9 |
| Minimum | 16.5 |
| Maximum | 227.4 |
| Sum | 2965 |
| Count | 33 |
| Confidence Level(95.0%) | 21.83743 |

| Site 3,6 inches (March) | |
|---|---|
| Mean | 70.46575758 |
| Standard Error | 7.454179897 |
| Median | 59.05 |
| Mode | 48.14 |
| Standard Deviation | 42.82100339 |
| Sample Variance | 1833.638331 |
| Kurtosis | 1.47852653 |
| Skewness | 1.410152504 |
| Range | 160.5 |
| Minimum | 24.92 |
| Maximum | 185.42 |
| Sum | 2325.37 |
| Count | 33 |
| Confidence Level(95.000%) | 14.6099025 |

| Site 3, 9 inches (Dec) | |
|---|---|
| Mean | 110.56875 |
| Standard Error | 16.506825 |
| Median | 76.65 |
| Mode | 59 |
| Standard Deviation | 93.376703 |
| Sample Variance | 8719.2087 |
| Kurtosis | 4.6089078 |
| Skewness | 2.1419364 |
| Range | 411.1 |
| Minimum | 24.3 |
| Maximum | 435.4 |
| Sum | 3538.2 |
| Count | 32 |
| Confidence Level(95.0%) | 33.66591 |

| Site 3, 9 inches (March) | |
|---|---|
| Mean | 71.57272727 |
| Standard Error | 9.633989578 |
| Median | 59 |
| Mode | 48.1 |
| Standard Deviation | 55.34305666 |
| Sample Variance | 3062.85392 |
| Kurtosis | 23.87339084 |
| Skewness | 4.580572038 |
| Range | 320.7 |
| Minimum | 37.5 |
| Maximum | 358.2 |
| Sum | 2361.9 |
| Count | 33 |
| Confidence Level(95.0%) | 19.62377799 |

| *Site 3,12 inches (Dec)* | |
|---|---|
| Mean | 118.265 |
| Standard Error | 15.259899 |
| Median | 107.35 |
| Mode | 185.4 |
| Standard Deviation | 80.747798 |
| Sample Variance | 6520.2069 |
| Kurtosis | 0.9343503 |
| Skewness | 0.9649896 |
| Range | 329.5 |
| Minimum | 19.9 |
| Maximum | 349.4 |
| Sum | 3311.42 |
| Count | 28 |
| Confidence Level(95.000%) | 29.908809 |

| *Site 3,12 inches (March)* | |
|---|---|
| Mean | 74.79969697 |
| Standard Error | 11.27557378 |
| Median | 61.81 |
| Mode | 61.81 |
| Standard Deviation | 64.77323996 |
| Sample Variance | 4195.572616 |
| Kurtosis | 12.74844194 |
| Skewness | 3.442423925 |
| Range | 333.23 |
| Minimum | 24.92 |
| Maximum | 358.15 |
| Sum | 2468.39 |
| Count | 33 |
| Confidence Level(95.000%) | 22.09968579 |

| *Site 3, 18 inches (Dec)* | |
|---|---|
| Mean | 101.27917 |
| Standard Error | 15.354489 |
| Median | 80.55 |
| Mode | 59 |
| Standard Deviation | 75.221325 |
| Sample Variance | 5658.2478 |
| Kurtosis | 3.9727061 |
| Skewness | 1.9148318 |
| Range | 312.7 |
| Minimum | 17.3 |
| Maximum | 330 |
| Sum | 2430.7 |
| Count | 24 |
| Confidence Level(95.0%) | 31.763137 |

| *Site 3,18 inches (March)* | |
|---|---|
| Mean | 92.53548387 |
| Standard Error | 11.37722444 |
| Median | 71.78 |
| Mode | 104.64 |
| Standard Deviation | 63.34570477 |
| Sample Variance | 4012.678312 |
| Kurtosis | 2.29775190 |
| Skewness | 1.453996854 |
| Range | 264.829999 |
| Minimum | 27.17 |
| Maximum | 292 |
| Sum | 2868.6 |
| Count | 31 |
| Confidence Level(95.000%) | 22.29891712 |

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